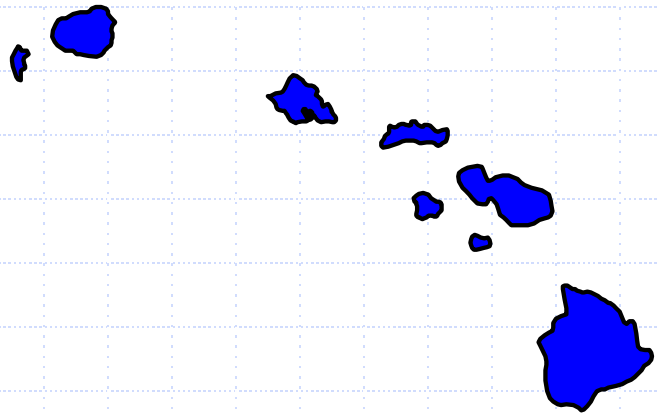
District Cooling for Honolulu's CBD

--Then and Now--

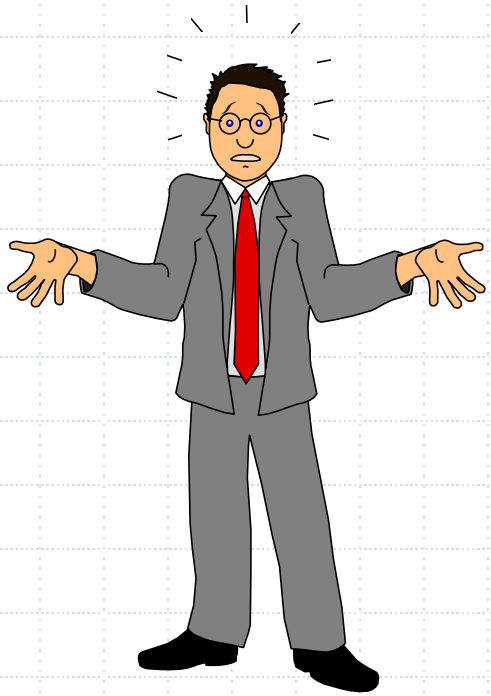


Agenda

- The demand for cooling
- Response(s) To-date
- What is district cooling?
- Development to date
- Benefits
- Next Steps

The Cooling Opportunity

- Many chillers are at the end of their useful life
- Clean Air Act banned the manufacture of CFCs
- Additional regulations are on the way
- Hard to find capital for non-core business investments

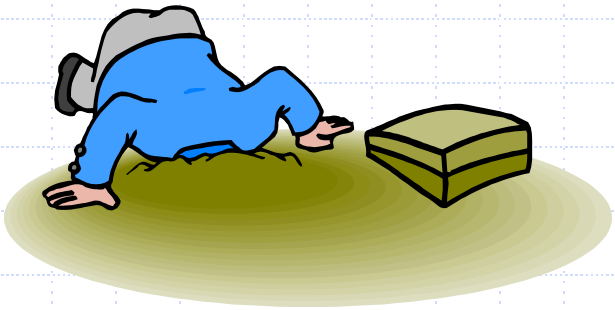


Possible Solutions

- ↓ Stockpile CFCs, do nothing
- ↓ Rebuild chillers for use with other refrigerants
- ↓ Replace chillers and refrigerants
- ↑ Outsource cooling requirements!

Stockpile CFCs

- Stockpile CFCs-
  - Hedges against cost increases
  - Entails additional risk
- Wait for a better answer
- Replace/rebuild costs increase
- Regulations/fines increase



The Demand for Cooling

- Air conditioning
- Process cooling
  - Computers
  - Communications
- Refrigeration
  - Walk-in coolers
  - Cold storage

Rebuild Chillers

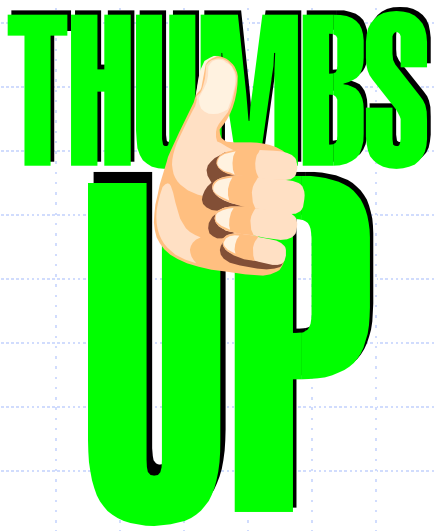
- Rebuild chillers/replace refrigerants
- A “retrofit”-technically difficult
- Probable capacity reduction
- Limited life, unknown problems ahead
- Risky refrigerant choices
- Capital used for non-core cost center
- Can be expensive!

Replace Chillers

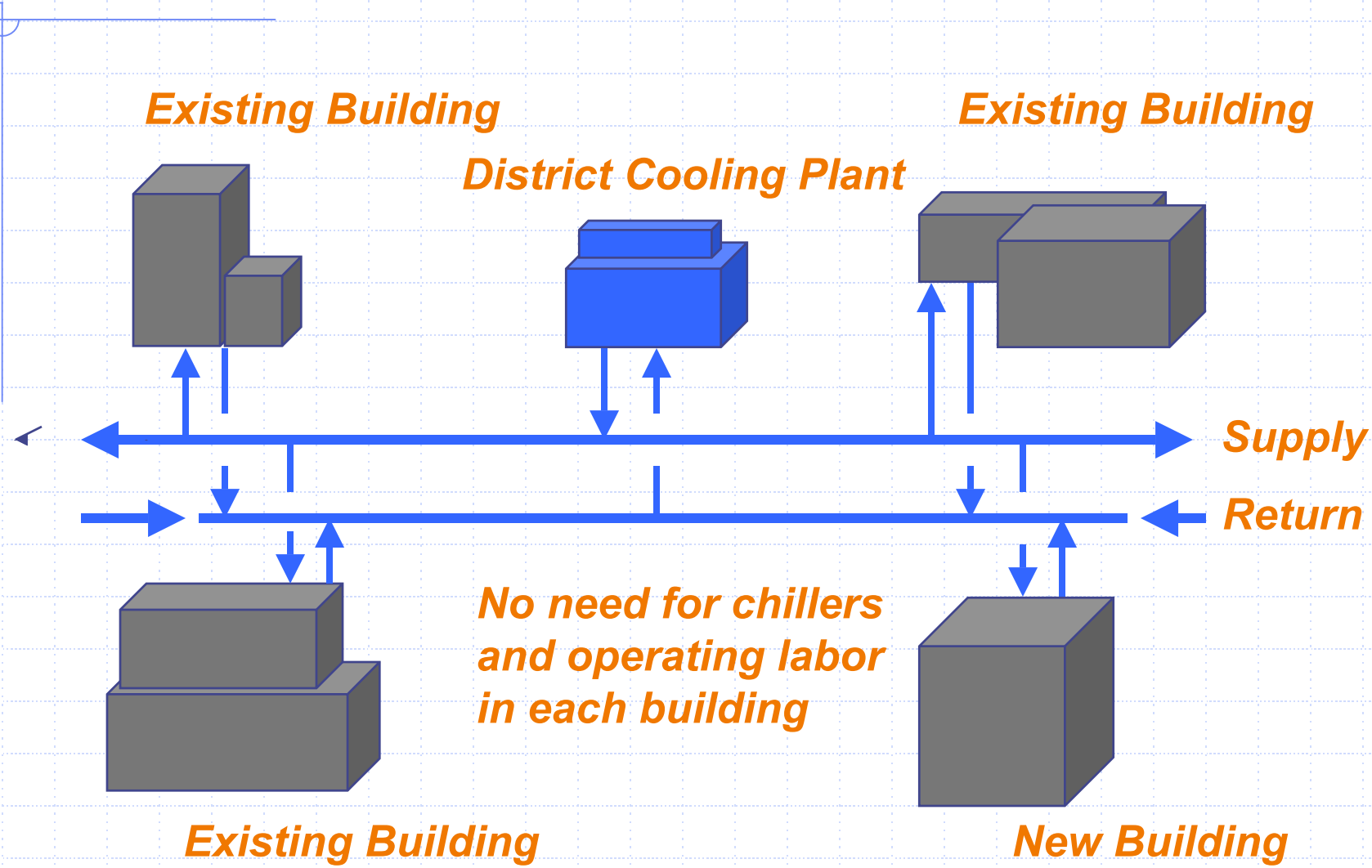
- Difficult to remove and install
- Complex, difficult to manage project
- Replace chillers and refrigerants
- Risky refrigerant choices
- Capital used for non-core cost center
- Can be very expensive!

Outsource Cooling

- *Eliminates building cooling plant-*
  - *Capital requirements*
  - *Operating and maintenance concerns*
  - *Environmental risk*
- ***Allows greater focus on core business!***



What is District Cooling?



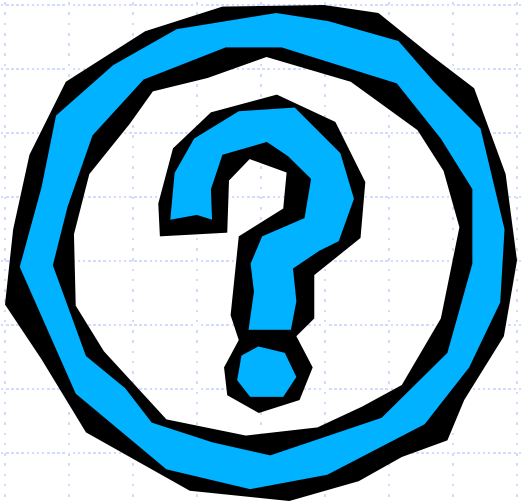
What is District Cooling?

- ***Centrally-supplied chilled water***
  - ***Available 24 hours/day, 365 days/year***
  - ***Totally meets building owner needs***
- ***Environmentally sound solution***
  - ***Eliminates building cooling plant CFCs, emissions, noise, plume***
  - ***Reduces ozone depletion and global warming***
  - ***Improves cooling efficiency***
- ***Easy Building Syndrome!!***

What is District Cooling?

- **Reliable service**
  - Proven, dependable technology
  - Interruptions virtually non-existent
  - 40 North American commercial systems
  - 2000 North American institutional systems
  - Also in Europe and Asia
- **Growth industry**
  - Growth rate of at least 15% annually
  - Most growth since 1990
- **Catalyst for economic development**
  - More competitive CBD
  - Bring jobs to the CBD

District Cooling Development Options

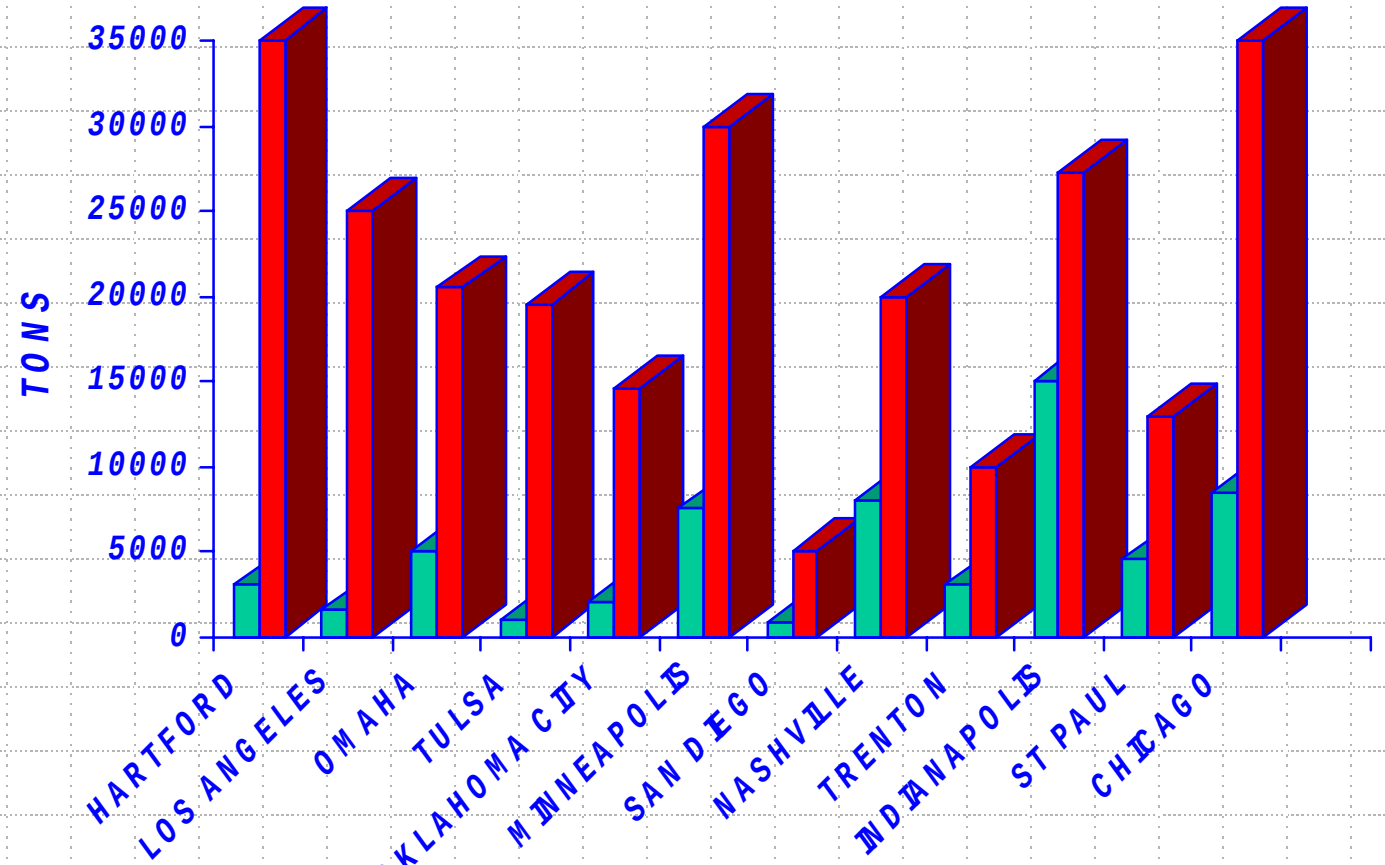


- Utilities
  - Electric
  - Gas
- Municipalities
  - Municipal utilities
  - Not-for-profit development companies
- Independents
  - Entrepreneurial energy companies
  - Customer cooperatives
- Hybrids of above

Responses To-date in 40+ North American Cities (so far)

- ***Educate & Energize Community leadership—public & private sectors!***
- ***Decide to meet customer needs by establishing a District Cooling service***
- ***Initiate process to begin operations in about 14-18 months***
- ***Initially focus on the downtown areas***

District Cooling Growth



Community Leadership

- *Got to have it!!*
- *Has come from public and private sectors*
- *Based on what's good for the community*
- *Sees the economic development benefits*
- *Often easier to educate than to energize*

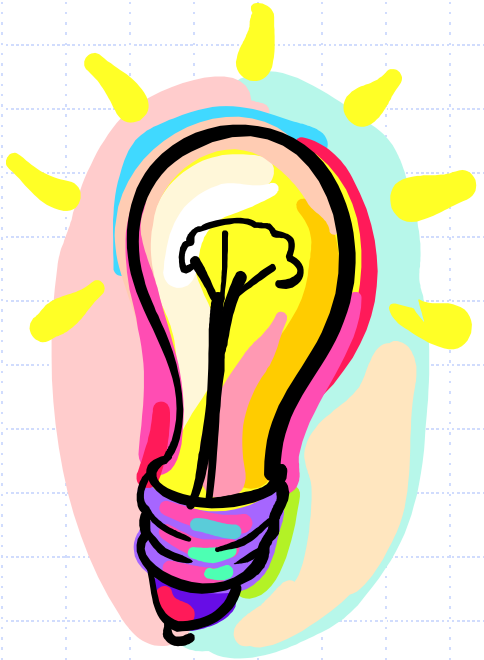
Customer Needs

- *A lot more than just air conditioning!!*
- *Eliminate and contain capital costs*
- *Reduce surprises & increase reliability*
- *Make building easier to own & operate*
- *Get cooling where needed, when needed*
  - *24/7 operation*
  - *Special events*
  - *After hours cooling*
  - *Data centers*

Risk Management
Risk Management

Operating in 14-18 Months??

- ***After anchor customers signed up!!***
- ***If you build it, they will come works in the movies—No "Field of Dreams"***
- ***Process includes***
  - ***Business appreciation study***
  - ***Technical & financial feasibility***
  - ***Service agreement terms***
  - ***Customer discussions, customer discussions, & concurrence***



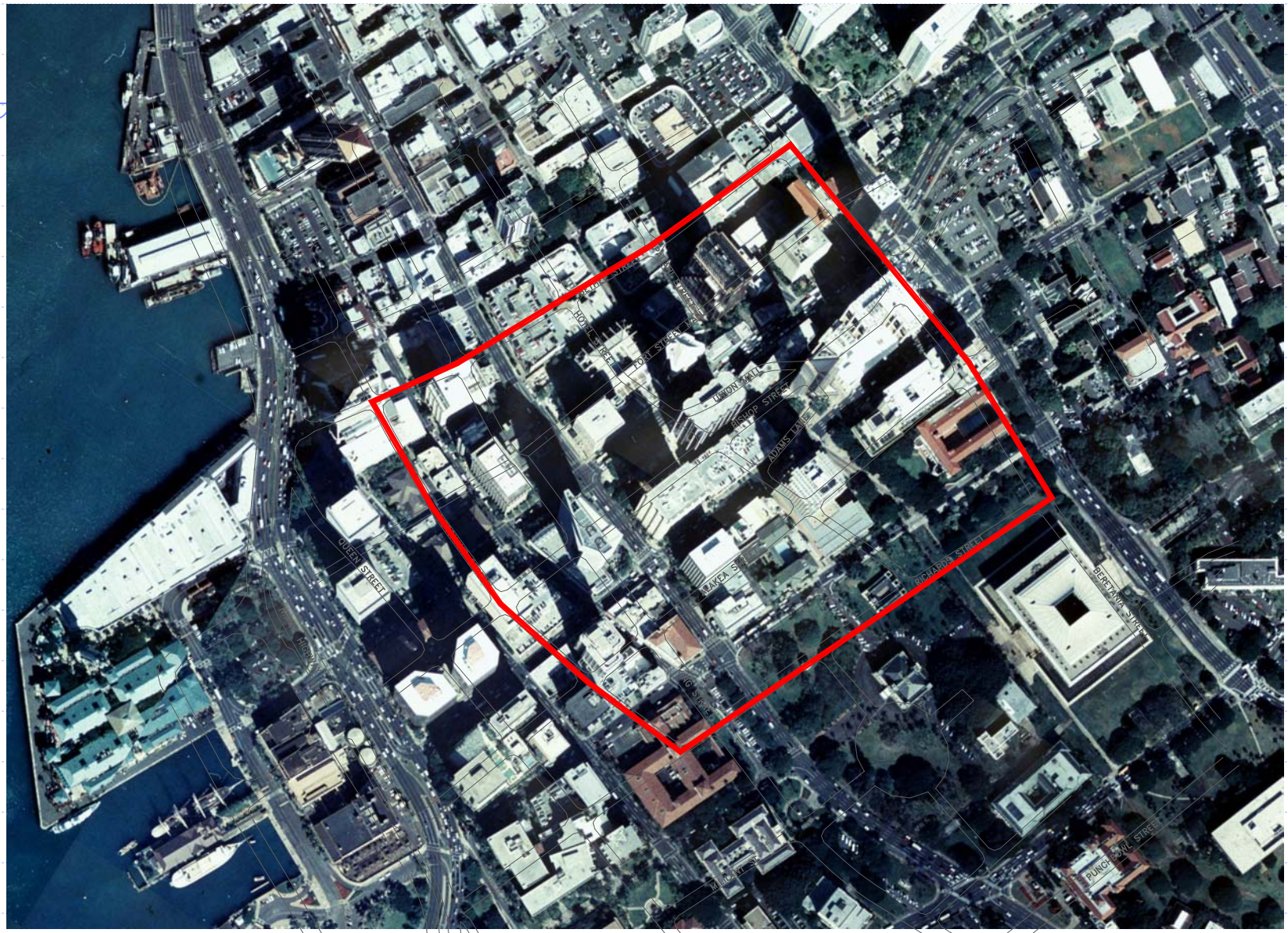
Initial Focus

- Downtown areas, Honolulu CBD
- Actually, Campus Areas
  - Educational
  - Health Care
  - Governmental
  - Industrial
  - Downtown

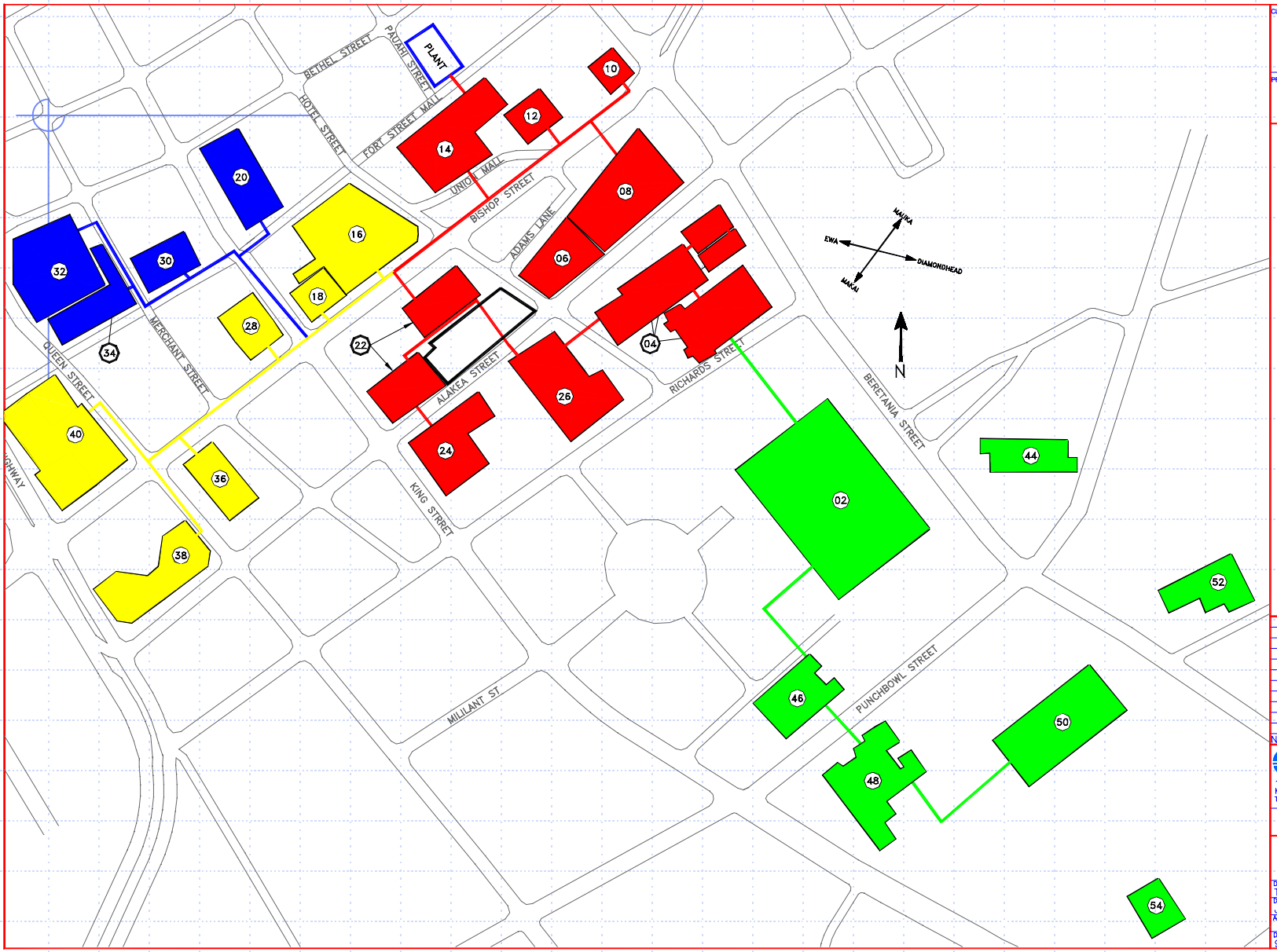
Project Description

- Four parts-a target market area, sources of chilled water, distribution network, and connections to customers' buildings
- Target Markets-Central Business Districts, educational and health care campuses
- Sources-chilled water plants, selected customer equipment, thermal storage, deep lakes, oceans
- Distribution Network-buried pipes: steel, ductile iron, HDPE
- Connections-heat exchangers, metering and controls installed in customers' buildings

Potential Area for District Cooling



HONOLULU PHASING



PHASE A
PHASE B
PHASE C
PHASE D

Bldg ID	Bldg Name
2	State Capitol
4	State Buildings (4)
6	1100 Alakea
8	Verizon-Hawaii
10	Century Square
12	Finance Factors
14	1132 Bishop
16	Executive Center
18	Bishop/Gasco
20	Liberty House
22	Bishop Square
24	Central Pacific Plaza
26	Alii Tower
28	Bank of Hawaii
30	Pioneer Plaza
32	Harbor Court
34	Campbell Building
36	Davies Pacific Center
38	Grosvenor Center
40	AMFAC
44	Kinau Hale
46	Hawaii State Library
48	Honolulu Hale
50	Kalanimoku Bldg
52	Honolulu Medical Group
54	Municipal Bldg

CLIENT: Entergy
Entergy Thermal, LLC.

PROJECT: DOWNTOWN HONOLULU DISTRICT COOLING DEVELOPMENT

REVISIONS

NO.	REMARKS	DATE
0	PRELIMINARY ISSUE	08/30/01

KATTNER/FVB DISTRICT ENERGY INC.
150 SOUTH FIFTH STREET, SUITE 340
MINNEAPOLIS, MINNESOTA 55402
TEL: (612) 338-4489 FAX: (612) 338-3427

POTENTIAL CUSTOMER PHASING MAP

DESIGNED BY: TL	SCALE: 1"=250'
DRAWN BY: JL	JOB NO.: 301227
APPROVED BY:	DRAWING No.: MAP-3
DATE: 9/14/01	

Chilled Water Sources

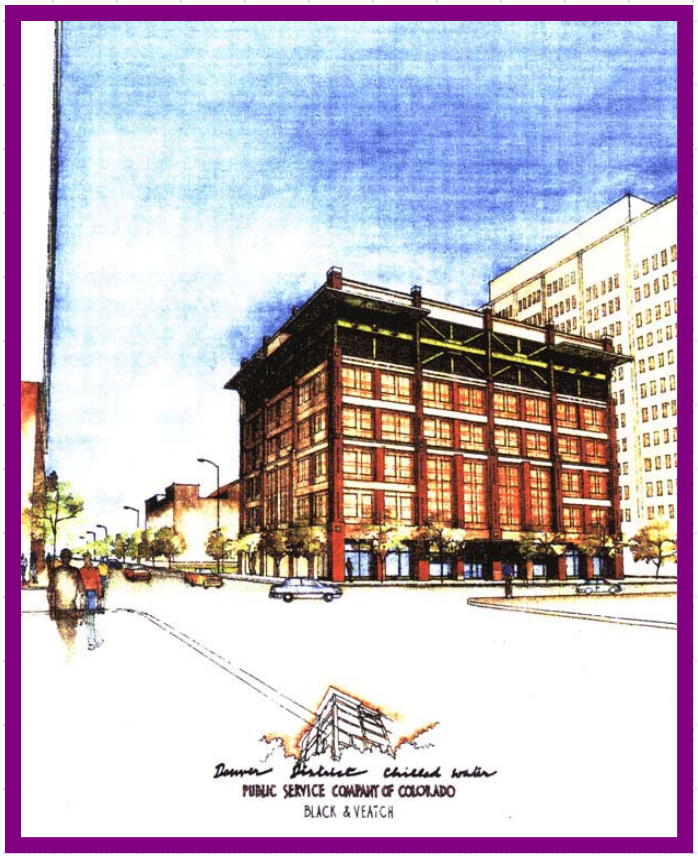
- Initial phase with expansion of selected existing chilled water plant(s)
- Expansion to new plant with large, efficient, industrial-grade chillers with thermal storage (ice), or
- Expansion to chilled water storage tank, or
- Expansion to ocean water based cooling, or
- Creative combinations

Chilled Water Plants

- 25,000 ton CHW plant
  - 7,000 tons from ice
  - 18,000 tons from mechanical cooling
- State and Adams St., Chicago, IL
- Subsidiary of Unicom Corporation

Chilled Water Plants

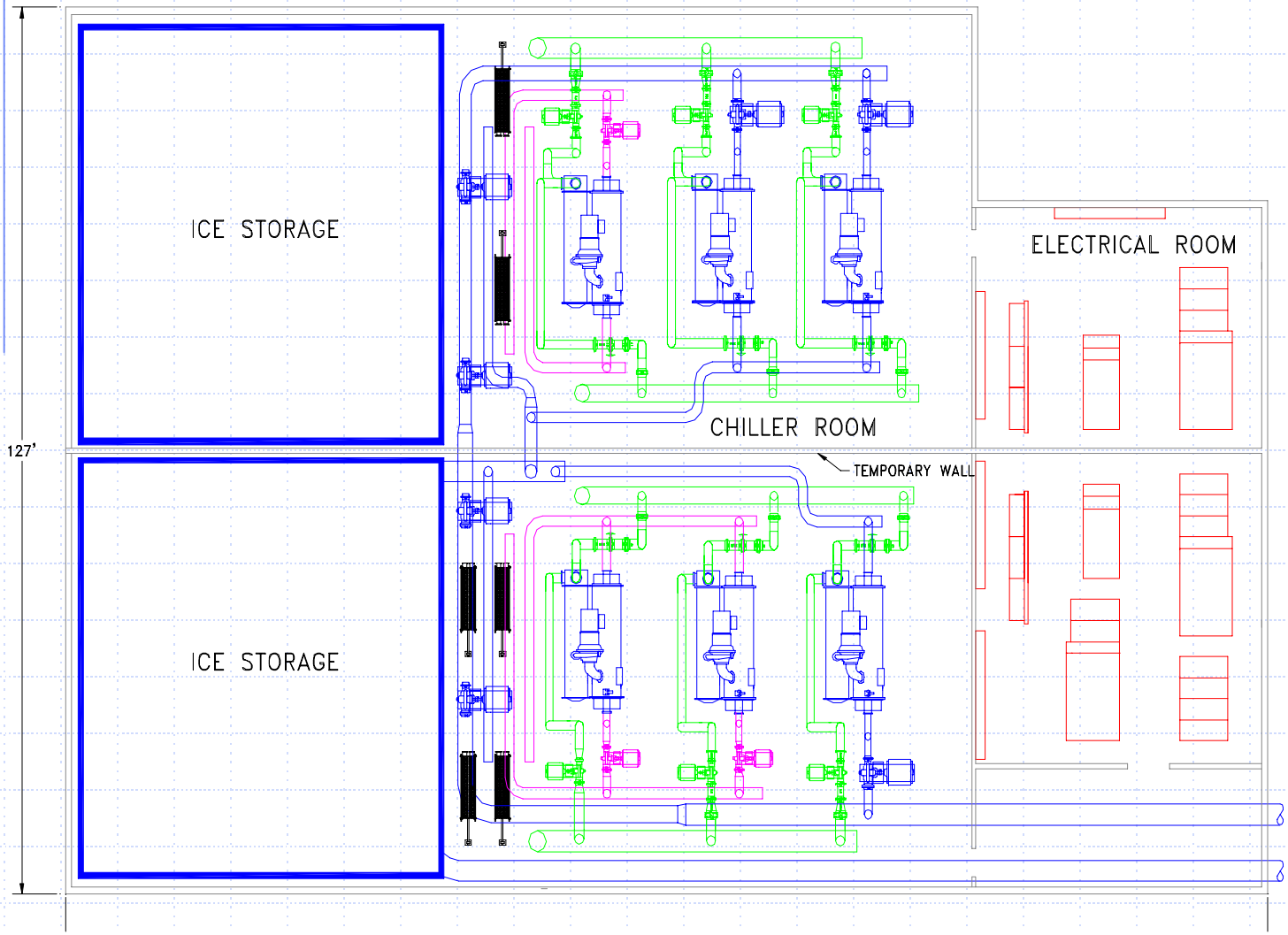
- 20,000 ton CHW plant
  - 5,000 tons from ice
  - 15,000 tons from mechanical cooling
- 15th and Glenarm, Denver, CO
- Public Service Co. of Colorado



Chilled Water Plants

- 32,000 ton plant
  - 52,000 t-hrs of storage
  - 20,000 tons of chillers
- 600 car parking
- 8MWe stand-by
- Medical Center
- Entergy-New Orleans

PRELIMINARY PLANT GENERAL ARRANGEMENT



NOT FOR CONSTRUCTION

REVISIONS		
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
DATE	REMARKS	NO.

FVB ENERGY INC
150 SOUTH FIFTH STREET, SUITE 340
MINNEAPOLIS, MINNESOTA 55402
TEL: (612) 338-4489
FAX: (612) 338-3427

Commercial Deep Water Cooling

- *Cornell University – fresh water lake*
- *Enwave Toronto – fresh water lake*
- *Stockholm – Baltic Sea plus heat pumps*
- *Sollentuna -- sea water plus aquifer storage*
- *Uppsala Väsby – deep water plus heat pump*
- *Nacka Strand – sea water*
- *Norrenergi – sea water*

Telgi Energi – Södertälje, Sweden

- Cold water from Lake Mälaren provides cooling to a large pharmaceutical plant and other commercial customers
- Production capacity 17,000 tons
- Supply temperature less than 48F all year long
- Source depth 148 ft
- Supply flow rate 26,400 gpm
- District cooling distribution 3.7 miles of 39 inch diameter polyethylene pipe

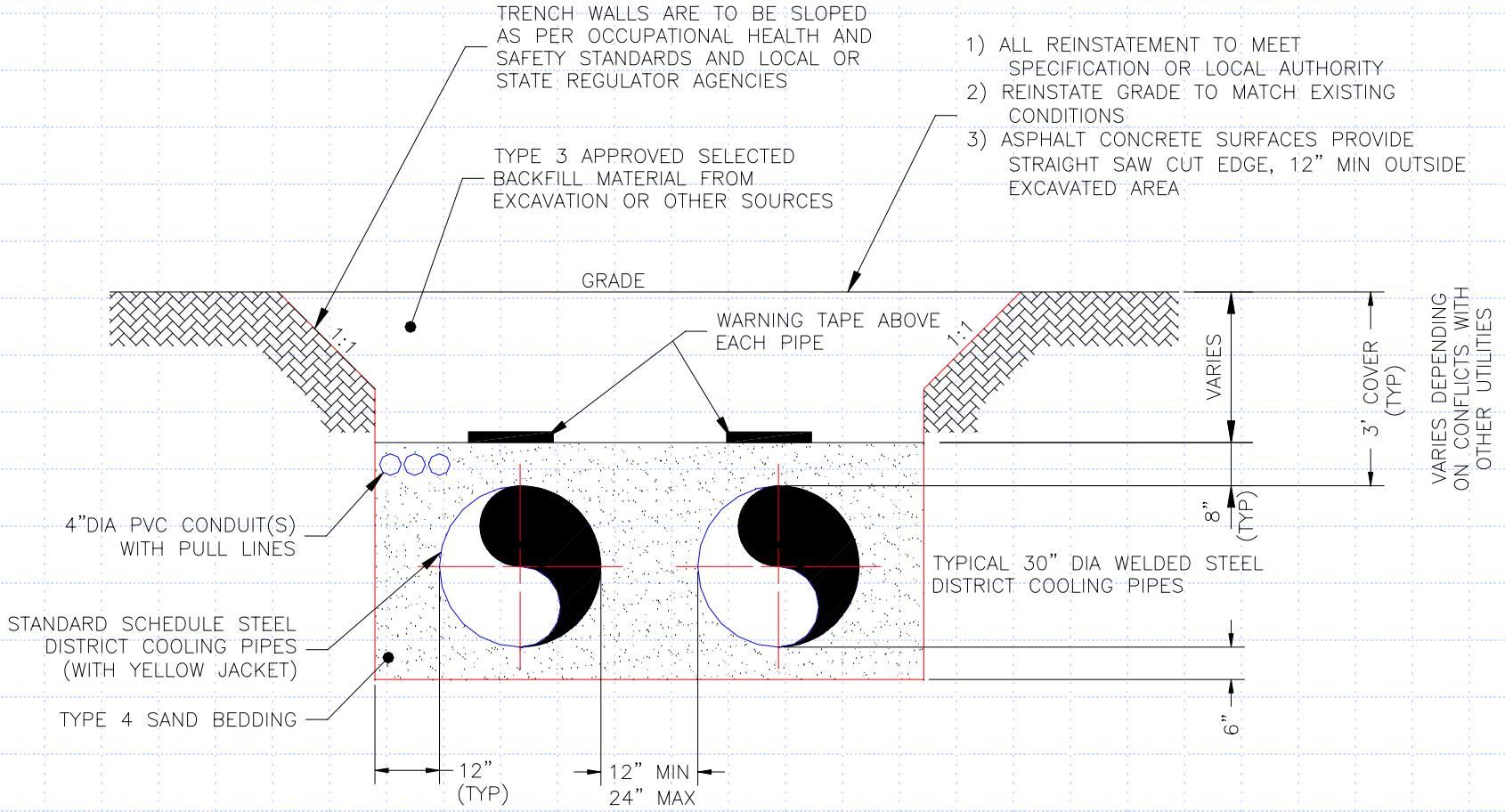
Pipe installation in Lake Mälaren

Sea Water Cooling in Stockholm

Distribution Network

- Closed system-water supplied is recycled and closely monitored for quality and quantity
- Two buried pipes-supply and return
- Piping material depends on subsurface conditions
- Chilled water supply is at 34-40°F, return at 50-54°F
- Includes conduits for communications

Typical Trench Detail for Chilled Water Pipes in City Streets



Distribution System

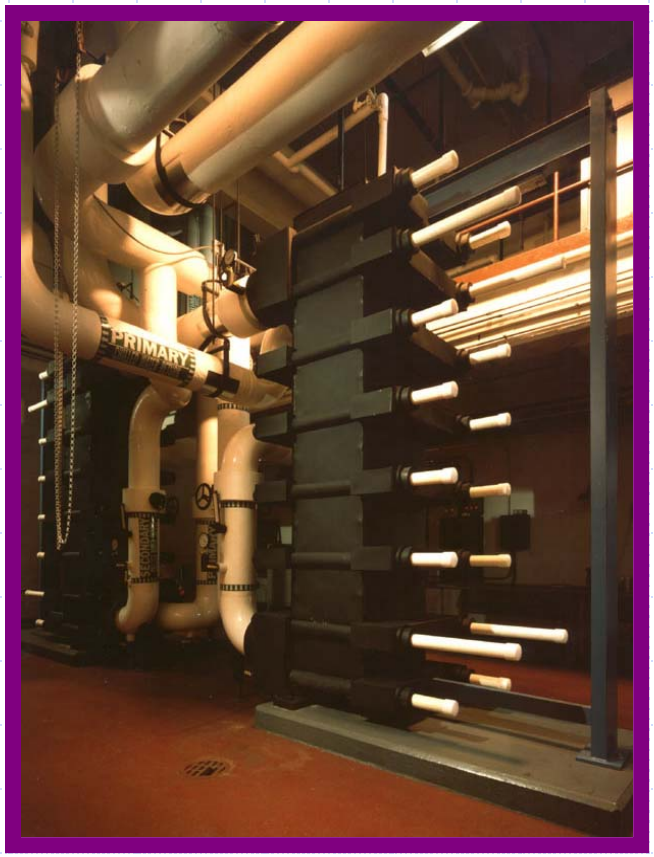
- Typical distribution installation
- Public Service Company of Colorado, Denver
- 24” Epoxy-coated welded steel pipe

Customer Connections

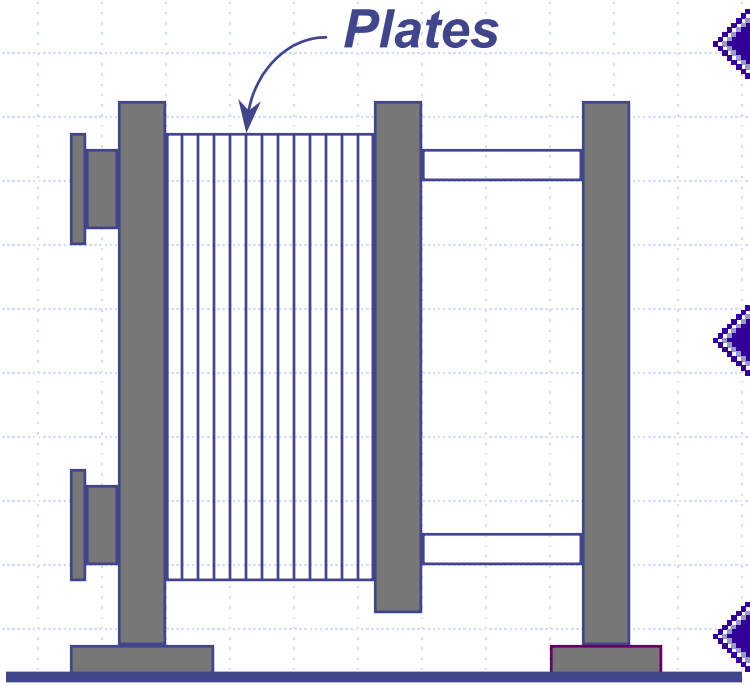
- ***Eliminated*-building chillers, cooling towers and refrigerants**
- ***Installed*-heat exchangers, piping, controls and metering**
- ***Operations*-clean, quiet, environmentally safe and easy**
- ***Reliability*-proven equipment, fewer moving parts**

Connections

- Typical connection in Chicago
- 30 story building, 850 ton peak cooling load.
- Two heat exchangers, piping, valves, controls
- Clean, quiet, zero emissions



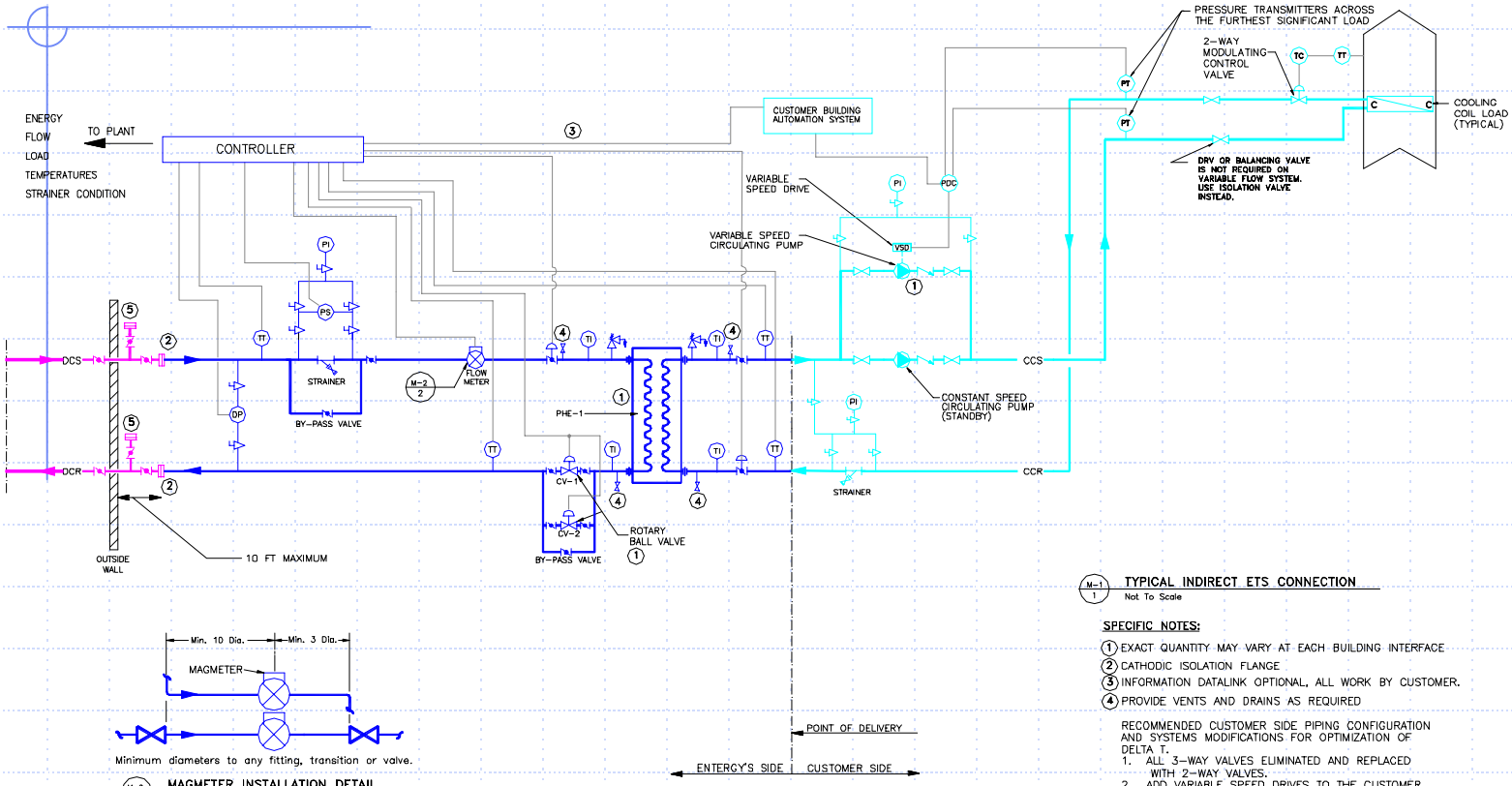
Connections



Energy Transfer Station
(Plate and Frame HX)

- *Easily increase capacity by adding plates*
- *Building and District Cooling water are separated*
- *Control systems set for desired temperatures*

TYPICAL INDIRECT INTERCONNECTION SCHEMATIC



M-1 / 1 TYPICAL INDIRECT ETS CONNECTION
Not To Scale

Minimum diameters to any fitting, transition or valve.

M-2 / 2 MAGMETER INSTALLATION DETAIL
Not To Scale

SPECIFIC NOTES:

1. EXACT QUANTITY MAY VARY AT EACH BUILDING INTERFACE
2. CATHODIC ISOLATION FLANGE
3. INFORMATION DATALINK OPTIONAL, ALL WORK BY CUSTOMER.
4. PROVIDE VENTS AND DRAINS AS REQUIRED

RECOMMENDED CUSTOMER SIDE PIPING CONFIGURATION AND SYSTEMS MODIFICATIONS FOR OPTIMIZATION OF DELTA T.

1. ALL 3-WAY VALVES ELIMINATED AND REPLACED WITH 2-WAY VALVES.
2. ADD VARIABLE SPEED DRIVES TO THE CUSTOMER CIRCULATION PUMPS.
3. MODIFY TEMPERATURE CONTROLS FOR THE ABOVE.

5. 8" VALVED EMERGENCY QUICK CONNECTIONS BY ENTERGY

TEMPERATURES ON THE CUSTOMER SIDE MAY DIFFER FROM THAT INDICATED. CONFIRM CONDITIONS WITH INDIVIDUAL BUILDINGS.

LEGEND

DCS – DISTRICT COOLING SUPPLY
DCR – DISTRICT COOLING RETURN
SCS – SECONDARY COOLING SUPPLY
SCR – SECONDARY COOLING RETURN
(PT) – PRESSURE TRANSMITTER
(PI) – PRESSURE INDICATOR
(TT) – TEMPERATURE TRANSMITTER
(TC) – TEMPERATURE CONTROLLER
(TS) – OUTSIDE AIR TEMPERATURE SENSOR
(PDC) – PRESSURE DIFFERENTIAL CONTR.
(DP) – DIFFERENTIAL PRESSURE SENSOR
(PS) – DIFFERENTIAL PRESSURE SWITCH

SYMBOLS:

GLOBE VALVE
SOLENOID VALVE
CATHODIC ISOLATION FLANGES
BALL VALVE
BFLY VALVE
GATE VALVE
CHECK VALVE
FLEXABLE JOINT
CAP
REDUCER
FLOW ARROW
TIE IN POINT
PIPE BREAK
NEEDLE VALVE
ELECT. ACTUATED ISO. VALVE
FLOW METER
PUMP
INST. TAG
CONTROL VALVE
STRAINER
TRAP
THREE WAY
DRAIN
PSV

REVISIONS		
–	–	–
–	–	–
–	–	–
–	–	–
–	–	–
–	–	–
DATE	REMARKS	NO.

FVB ENERGY INC
150 SOUTH FIFTH STREET, SUITE 340
MINNEAPOLIS, MINNESOTA 55402
TEL: (612) 338-4489
FAX: (612) 338-3427

PROJECT TITLE:

SHEET TITLE:

DGN:	SCALE:
DWN:	JOB NO.:
APPR:	DATE:
DWG NO.:	SK-02

Building Owner Benefits

- **No capital risk** to replace or rebuild
- **No operating risk** to operate and maintain a plant
  - Maintenance and repairs
  - Chemicals
  - Water
  - Insurance and taxes
  - Labor
  - Security
- **No refrigerant risk**
  - Selection
  - Disclosure
  - Storage
  - Handling

Building Owner Benefits

- **Improves cooling performance**
  - Quick response
    - Cool down following a hot weekend
    - Abrupt changes in temperature
  - Available 24 hrs per day, 365 days per year
- Improves comfort in previously hard to cool spaces
- Opportunity to decrease building energy use
- After hours cooling easier and more economical

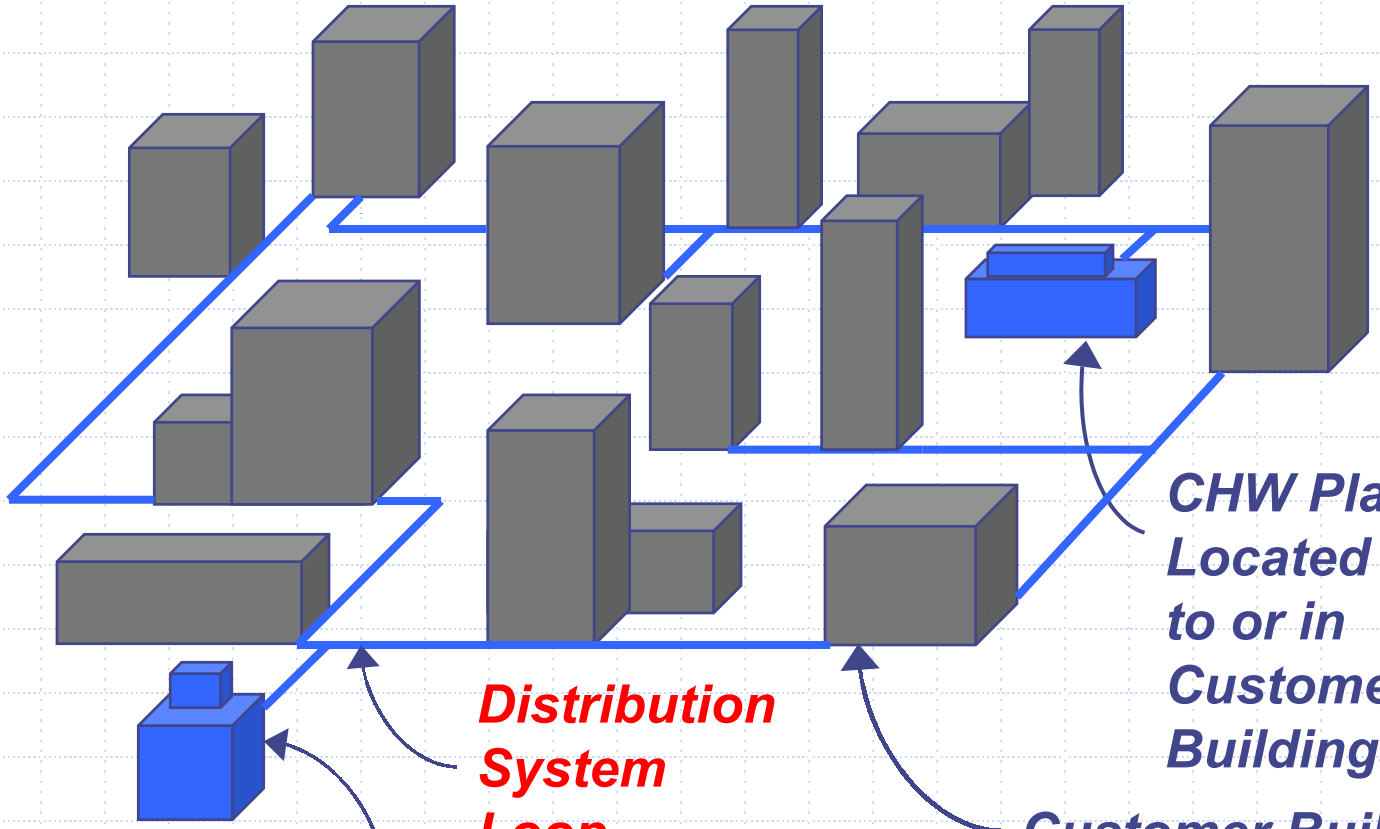
Building Owner Benefits

- ***Improves reliability***
  - *Multiple industrial-grade chillers*
  - *High reliability design*
  - *Machines and storage*
  - *Distribution network*
- ***Eliminates environmental concerns***
  - *Refrigerants, water treatment chemicals*
  - *Noise, vibration, health and safety issues*
  - *Water use*
  - *Wastewater discharges*

Building Owner Benefits

- ***Releases space*** *for more productive uses*
- ***Increases security*** *by reducing service vendors and vehicles*
- ***Easier building*** *to own, operate and maintain*
- ***More predictable*** *financially, operationally*
- ***Allows focus on core business!***

Ultimate Development



City of Honolulu Benefits

- ***Supports economic development***
  - *Adds new infrastructure and business to the CBD*
  - *New projects no longer need cooling plants*
  - *Renovations can focus $$ on competitiveness*
  - *Local construction jobs*
  - *Long-term district cooling employment*

City of Honolulu Benefits

- ***Adds new opportunities-***
  - *Thermal storage to reduce electric demand and $$*
  - *Ocean water as renewable energy source*
  - *Conservation of freshwater*
- ***Eliminates-***
  - *Deteriorated cooling towers*
  - *Aged chillers*
  - *Stress on local electric utility distribution system*

Summary

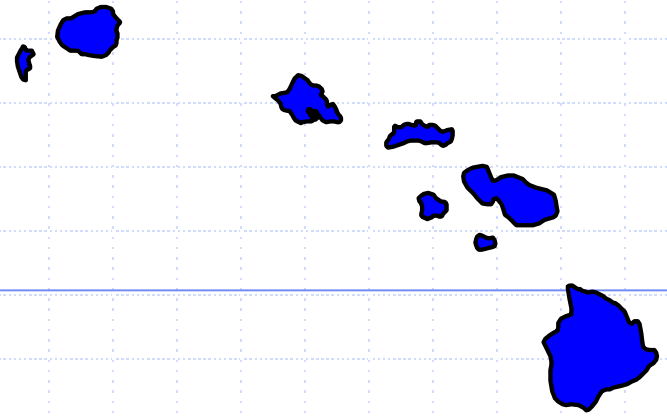
- **District Cooling is…**
  - A proven way to cool educational, health care, industrial and urban campuses
  - A flexible system that works well with thermal storage and sea water for AC
  - A financial, operational and environmental risk management strategy

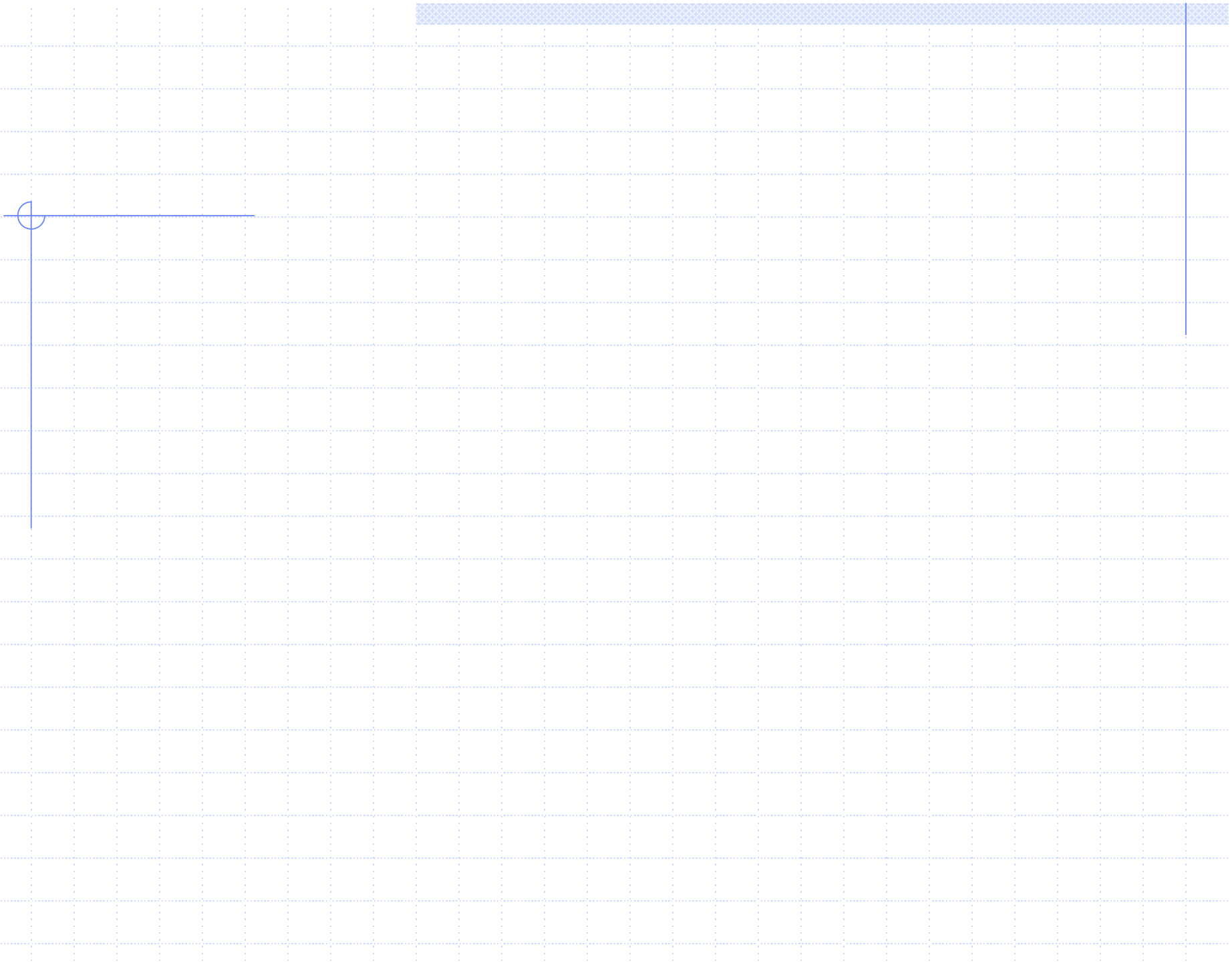
Summary

- **District Cooling is…**
  - Good for the end-users
  - Good for Honolulu
  - Good for Hawaii

District Cooling for Honolulu

—Tomorrow ??—





Why Ice Storage?

- Reduces investment costs
  - Smaller distribution pipes
  - Smaller connection equipment
- Shifts some cooling to off-peak
- Provides low temperature CHW
- An extra measure of redundancy
- Makes sense to the public!

City of Honolulu Benefits

- ***Improves environmental compliance***
  - *Large, efficient, industrial-grade chillers*
  - *Refrigerants- minimum ODP and GWP*
  - *Minimum noise and plume production*
  - *Experienced staff dedicated to CHW production*

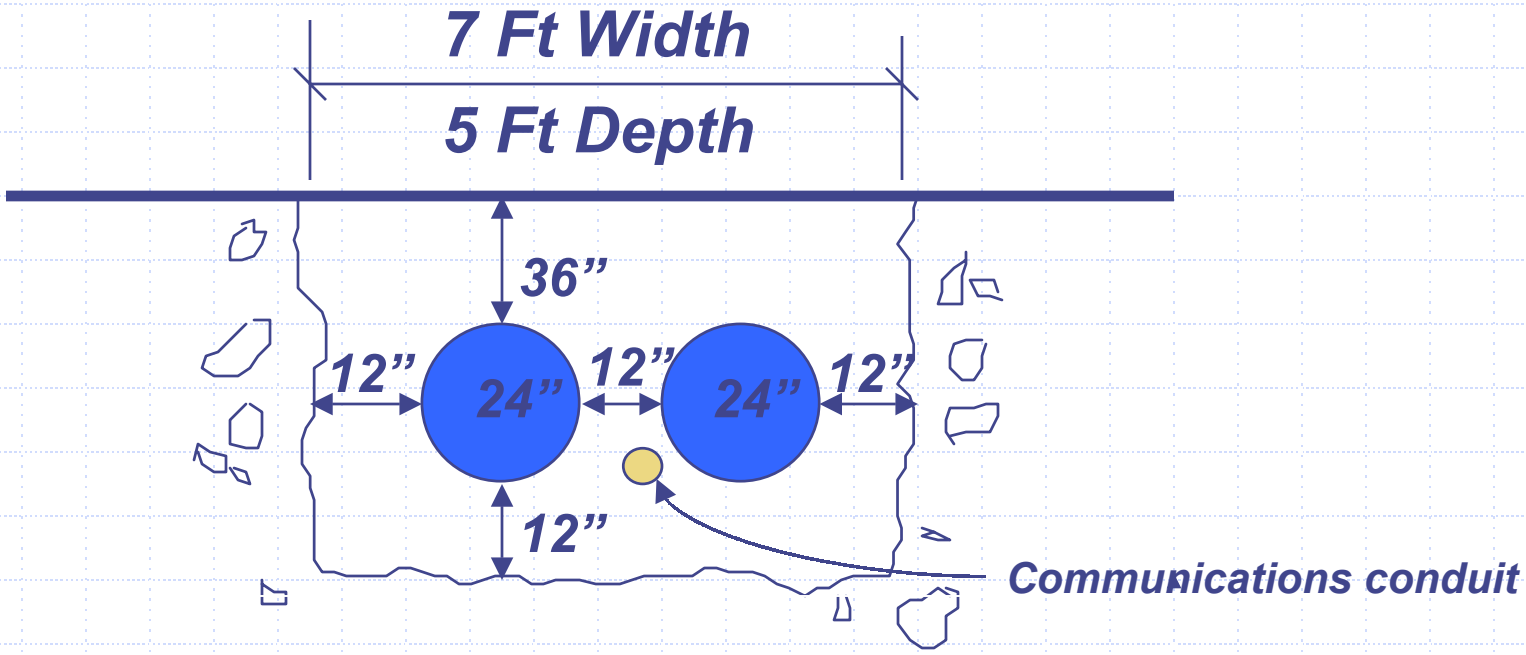
Summary

- **Good for customers!**
  - Satisfies a need
  - Eliminates environmental concerns
  - Improves cooling performance
  - Increases reliability
- **Good for the city!**
  - Supports economic development
  - Beautifies the city
  - Improves the environment

A Winning Solution!

Pump station installed on rock in shallow water in Lake Mälaren

Distribution System-typical



Sollentuna Energi – Sollentuna, Sweden

- *Production capacity 1,100 tons*
- *Aquifer storage capacity 730,000 ton-hrs*
  - *Supply temperature 45F*
  - *Source depth 50 feet*
- *Pipe materials*
  - *Polyethylene for pipe installed in the bay*
  - *Carbon steel for underground pipe*
  - *Stainless steel for customer connections*

Integration of Deep Water Cooling and Seasonal Aquifer Storage -- Sollentuna